Addition of a Digital Receiver to the X-BADGER Radar System

Completed Technology Project (2013 - 2015)

Project Introduction

Over the past year, the X-Band Atmospheric Doppler Ground-based Radar (X-BADGER) transmitter has undergone a major upgrade from a high voltage traveling-wave tube to a solid-state power amplifier (SSPA). For X-BADGER to reach its highest potential, the addition of a digital receiver is necessary to utilize the recent hardware upgrade. The small size and mobility of X-BADGER makes it attractive for field deployment for ground validation (GV) of spaceborne missions involving precipitation and the hydrological cycle, such as the Global Precipitation Measurement (GPM) mission, Surface Water and Ocean Topography (SWOT), and the Soil Moisture Active Passive (SMAP) mission.

The X-BADGER system is based on the ER-2 Doppler (EDOP) radar, which was built in 1994, flown in multiple field campaigns, and worked consistently as a ground-based vertically pointing radar with an antenna on the rooftop of Building 33 from 2007 until 2011. The objective of this year's IRAD project is to complete the creation of a new solid-state radar with two digital receivers. One digital receiver will be dedicated for the zenith beam and the other will be dedicated for the horizontal and vertical channels for the dual polarimetric forward pointing beam. In the previous EDOP system, the data required post-processing after the transmitter stopped. The addition of digital receivers will allow for real-time processing of data and creation of Quicklooks in near real-time, which is crucial for field campaign performance. An additional benefit of upgrading to a digital receiver is that all of the radars in the Microwave Sensors Lab use the same type of digital receiver.

As soon as the installation of the two digital receivers to X-BADGER is complete, the radar will move to Wallops for long-term deployment as part of the GPM Wallops Precipitation Research Facility (PRF) for Error Characterization led by Dr. Walt Petersen (GPM Ground Validation Science Manager). The radar will be used for studies involving precipitation error characterization, variability in satellite field of view (FOV), and precipitation vertical profile physics. In the future, it is envisioned that X-BADGER could be deployed as part of the existing GSFC/WFF PRF multi-frequency radar infrastructure for support of additional future mission field campaign studies. We are poised to obtain funding for the GPM OLYMPEX field campaign in FY16 if X-BADGER is completed and initial testing of the radar in an operational setting is completed during FY15.

Anticipated Benefits

NASA has developed missions for global measurement of the water cycle, including GPM to measure precipitation globally, SWOT to directly measure surface water, and SMAP to measure near-surface soil moisture. However, ground validation of satellite products will continue to remain an essential part

This image shows the custom modification to the X-BADGER research trailer. The top of the white box is a custom built radome that allows for the radar beam to travel through, but protects the interior of the trailer from rain and hail.

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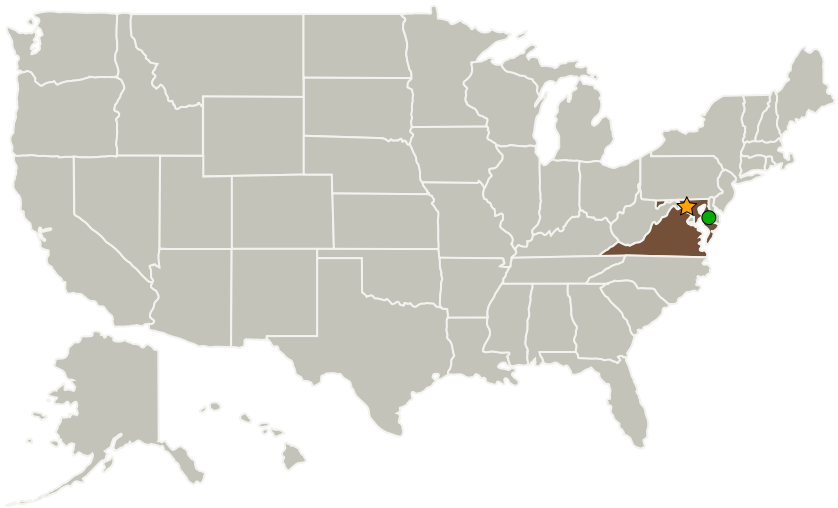
of future mission success. The outcome of this work will fill the gap in ground-based radars, and in particular relatively non-attenuating precipitation profiling radars, in the current NASA GV radar suite.

Although there are a number of horizontally scanning ground-based radars of various wavelengths or downward pointing airborne radar platforms, the ground-based set up of X-BADGER is unique in the fact that it is vertically pointing. By adding in both the zenith and forward-pointing beams, detailed information, such as drop size distribution, which is critical for improved quantitative precipitation estimation, can be obtained while working in concert with other ground-based horizontally scanning radars that span attenuating and non-attenuating frequencies. The upgrade to include the forward-pointing beam will also provide the LDR polarimetric variable. This attribute is important both in the short-term GV efforts to improve mixed phase detection algorithms for the upcoming GPM mission but also significantly improves strategic capabilities to compete for future missions where information on cloud droplet to precipitation-sized raindrop transition is critical. Unlike NPOL and TOGA, which require disassembly of the radar and placement into shipping containers to move, X-BADGER requires no disassembly and the trailer that it is housed in can be hooked to an automobile and relocated anywhere. The radar is compact enough that it can even be placed on a research vessel for field campaigns at sea. The upgrade to X-BADGER to allow for mobile container-based deployment makes the instrument an ideal candidate for future scientific studies.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

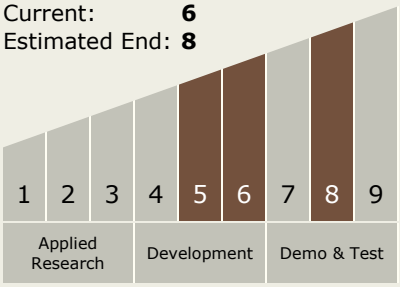
Matthew J Mcgill

Principal Investigator:

Amber E Emory

Technology Maturity (TRL)

Start: **5**
Current: **6**
Estimated End: **8**



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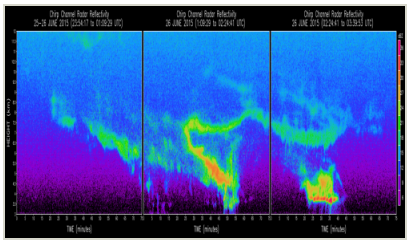
Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
●Wallops Flight Facility(WFF)	Supporting Organization	NASA Facility	Wallops Island, Virginia

Primary U.S. Work Locations	
Maryland	Virginia

Images



Addition of a Digital Receiver to the X-BADGER Radar System Project
Addition of a Digital Receiver to the X-BADGER Radar System Project *(https://techport.nasa.gov/image/19349)*

X-BADGER
The X-BADGER radar and waveguide housed in a repurposed server rack. *(https://techport.nasa.gov/image/4180)*

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

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X-BADGER Research Trailer
This image shows the custom modification to the X-BADGER research trailer. The top of the white box is a custom built radome that allows for the radar beam to travel through, but protects the interior of the trailer from rain and hail.
(https://techport.nasa.gov/image/4179)

Links

NTR 1438094120
(no url provided)

Project Website:

http://sciences.gsfc.nasa.gov/sed/